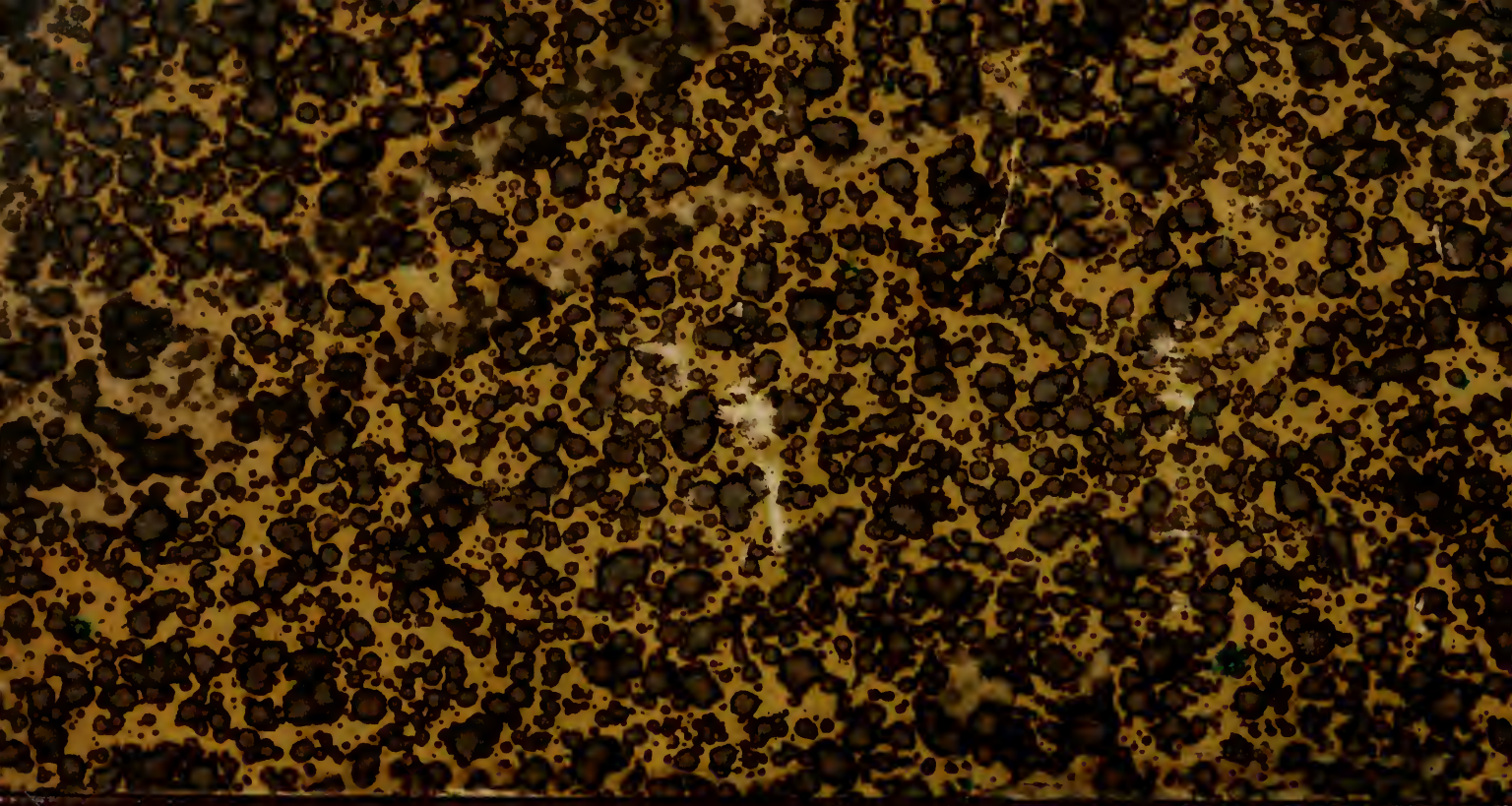

UNIVERSITY OF ILLINOIS BULLETIN

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COURSES IN CERAMICS

AT THE

UNIVERSITY OF ILLINOIS

1905-1906

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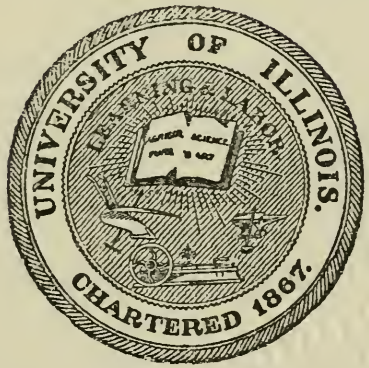
AT THE

UNIVERSITY OF ILLINOIS



1905-1906

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THE UNIVERSITY CALENDAR

1906-1907

FIRST SEMESTER

September 12, Wednesday.	Entrance Examinations begin.
September 17, 18, Monday and Tuesday.	Registration Days.
September 19, Wednesday.	Instruction begins.

1905-1906

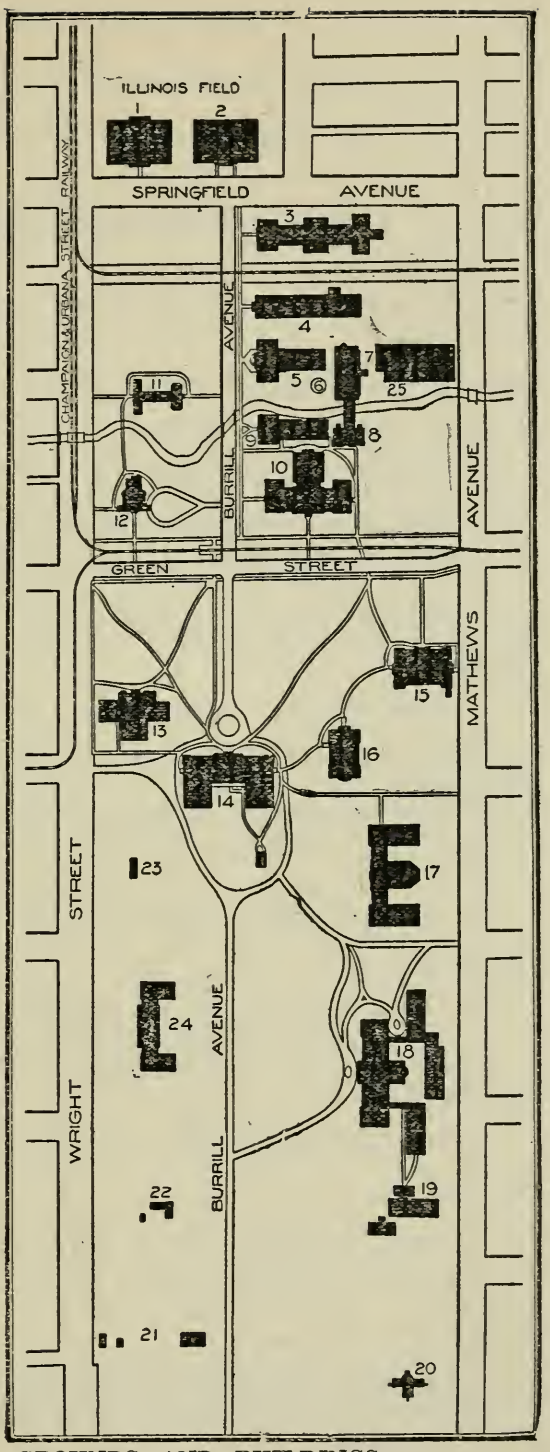
SECOND SEMESTER

February 5, Monday.	Instruction begins.
June 13, Wednesday.	Thirty-fifth Annual Commencement

ADVISORY COMMITTEE

W. D. GATES	Chicago
D. V. PURINGTON	Chicago
F. W. BUTTERWORTH	Danville
J. W. STIPES	Champaign
A. W. GATES	Monmouth

Men's Gymnasium
2 Armory
3 Wood Shop and Foundry
4 Metal Shops
5 Electrical and Mechanical Laboratory
6 Reservoir
7 Heating Plant
8 Pumping Plant
9 Laboratory of Applied Mechanics
10 Engineering Hall
11 Greenhouse
12 President's House
13 Library
14 University Hall
15 Natural History Hall
16 College of Law
17 Chemical Laboratory
18 Agricultural Buildings
19 Greenhouse
20 Observatory
21 Warehouse
22 Veterinary Building
23 Insectary
24 Woman's Building
25 Mechanical Engineering Laboratory



UNIVERSITY GROUNDS AND BUILDINGS

INSTRUCTORS.*

EDMUND JANES JAMES, PH. D., LL. D., President of the University.

GEOLOGY AND CERAMICS.

CHARLES WESLEY ROLFE, M. S., Professor of Geology. Director of Courses in Ceramics.

HARRY BERT FOX, M. S., Instructor in Geology.

J. CLAUDE JONES, A. B., Instructor in Geology.

ROSS C. PURDY, Instructor in Ceramics.

CHEMISTRY.

SAMUEL WILSON PARR, M. S., Professor of Applied Chemistry.

HARRY SANDS GRINDLEY, SC. D., Professor of General Chemistry.

AZARIAH THOMAS LINCOLN, PH. D., Assistant Professor of Chemistry.

WILLIAM MAURICE DEHN, PH. D., Instructor in Chemistry.

MATHEMATICS.

EDGAR J. TOWNSEND, PH. D., Professor of Mathematics.

HENRY LEWIS RIETZ, PH. D., Assistant Professor of Mathematics.

ERNEST BARNES LYTLE, A. M., Instructor in Mathematics.

PHYSICS.

ALBERT PRUDEN CARMAN, SC. D., Professor of Physics.

CHARLES TOBIAS KNIPP, PH. D., Assistant Professor of Physics.

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*Aside from the President, only those members of the corps of instruction are included who give courses described in this circular. For other Instructors in the various departments see the University Catalog.

FLOYD ROWE WATSON, PH. D., Assistant Professor of Physics.

WILLIAM FREDERICK SCHULTZ, E. E., Instructor in Physics.

ENGINEERING.

ARTHUR NEWELL TALBOT, C. E., Professor of Municipal and Sanitary Engineering.

VICTOR TYSON WILSON, M. E., Assistant Professor of General Engineering Drawing.

ROY HARDY SLOCUM, B. S., Instructor in Theoretical and Applied Mechanics.

ROY IRVIN WEBBER, B. S., Instructor in Civil Engineering.

R. C. MATHEWS, B. S., Instructor in Mechanical Engineering.

JOHN MYRON BRYANT, B. S., Instructor in Electrical Engineering.

CHARLES RICHARD CLARK, B. S., Instructor in Architectural Construction.

ART AND DESIGN.

FRANK FORREST FREDERICK, Professor of Art and Design.

EDWARD JOHN LAKE, B. S., Assistant Professor of Art and Design.

LANGUAGE.

GEORGE HENRY MEYER, A. M., Assistant Professor of German.

THOMAS ARKLE CLARK, B. L., Professor of Rhetoric.

UNIVERSITY AT LARGE.

The act of Congress upon which the University of Illinois was founded imposed upon it the duty to "promote the liberal and practical education of the industrial classes in the several pursuits and professions of life" and at the same time expressly stipulated that the lines of study which until then had almost exclusively engaged the energies of college faculties were not to be neglected.

That the University has tried to meet this double obligation is shown in the organization of its Colleges of Agriculture, Engineering, Literature and Arts, Science, Law, Medicine, and Dentistry; its Schools of Education, Library Science, Music, and Pharmacy; and its courses in Commerce and Household Science; as also in its Agricultural Experiment Station, Engineering Experiment Station, Water Survey, Geological Survey, Biological Survey, Laboratory of Natural History and Food Laboratory. To these are now added for the first time courses in Ceramics.

The grouping of so wide a range of educational interests under a single management not only places each under the most favorable conditions for its rapid and complete development and for the economical management of its affairs, but the association of so large a number of investigators, each a specialist in his own line, under the inspiration of a common purpose, insures the employment of more effective methods of in-

vestigation and the accomplishment of larger and more trustworthy results.

OBJECTS AND AIMS OF THE COURSES IN CERAMICS.

The study of Ceramics has to do with the applications of physical science to the manufacture of wares made wholly or in part from clay. The conditions under which ceramic products may be successfully and profitably produced are so complex and exacting as to require special scientific training for the prospective ceramist. Low interest rates and cheap transportation have so broadened the field of competition that each manufacturer must look sharply to the quality of his wares and to the cost of production. He must not only know the qualities of the materials he is using and of all other deposits so situated that they may possibly be of commercial use, but he must know what changes he can produce in his wares by various admixtures in body or glaze or by changes in methods of treatment.

He must know what machinery, what fuel, and what ways of handling are best suited to the materials he must use, what grades of ware he can produce and the cost of each. He must not only have this information in regard to the materials he can obtain on a commercial basis, but also like information concerning those within the reach of each of his competitors, if he would enter into successful competition with them.

Reliable information and scientific training along the lines indicated above are not easily gained by a young man through apprenticeship, no matter how large the factory is in which he may be employed, nor even by expert service in some one department of the industry in several factories; but this training may be

acquired in a comparatively short time thru a well planned course of study properly supplemented by practical work. The best preparation for the management of large ceramic interests is not to be found in the factory or in the yards, but in a school with courses and equipment especially adapted to the purpose, and under instructors with broad training.

This does not mean that ability to manage successfully any large business enterprise can be acquired in school. There is a large element of practical experience which can only be obtained by actual contact with the business world and with the details of the special line of business in which one embarks. *The school ought to give the student mental strength, knowledge of principles and methods, skill in the manipulation of apparatus, training in scientific methods of experimentation and in the interpretation of results, familiarity with fundamental processes covering the whole field of research with which it is engaged, and then "turn him into practical life while he still retains the plasticity of character necessary to enable him to adapt himself to the conditions," which he will meet in the particular branch of industry to which he shall devote himself.*

It is not expected that the student upon graduation will be able to manage successfully a large manufacturing plant. It is expected, however, that he will be in a position to acquire this ability very rapidly when brought in practical contact with the problems of the factory, and that having reached this stage he will thereafter be stronger and in every way more capable than he would have been if he had not come under the influence of the school. It is believed the courses here offered will afford such training.

SUBJECTS FOR STUDY.

As all the changes which come to ceramic materials during the processses of manufacture are either chemical or physical, and as some of them are exceedingly complex in character, a course of study which shall carry out the purpose indicated above must furnish such training in chemistry and physics as will enable the student to understand these changes, and to modify and control them by varying his methods of manipulation. Many plants have been abandoned, entailing large loss on the owners, many others have been removed, and still others have discontinued the manufacture of profitable wares in consequence of difficulties which might easily have been overcome by one familiar with the chemistry and physics of clay manufacture.

The materials with which the ceramist has to deal vary widely in composition and qualities. These differences are largely due to to the peculiar conditions under which each deposit was formed. The recognition of these conditions and the changes they produce upon the minerals and rocks which make up the crust of the earth, transforming them into substances useful or otherwise to the ceramist, is the province of Mineralogy and Geology.

The ceramist uses large quantities of heavy materials, and in order to handle them economically he must employ heavy and often complex machinery in mining, transporting, preparing and shaping these materials, and in the transportation of his wares. He should then have such familiarity with machines and with the principles of engineering as will enable him to install and operate his apparatus and keep it in repair and also to manage his power effectively and economically. To do this efficiently he must have some knowledge of me-

chanical and electrical engineering, and these again require familiarity with mathematics, mechanics, and resistance of materials.

As the European peoples are particularly active and efficient in ceramics, and as the results of much of their best work are recorded only in their own languages, the ceramist who would keep abreast of the world in his profession must have some acquaintance with foreign languages, and as society measures a man's worth largely by his ability to express his thot clearly and correctly, training in English is also essential.

The young man who wishes to devote his life to the development of any branch of clay industry must, if he would do his work in the best manner, become familiar with the principles which underlie every branch of ceramics. The progressive brickmaker must know the hows and whys which control the potter in the manufacture of his bodies, glazes, and glasses, or the maker of terra-cotta or art wares, as well as those which pertain more directly to his line of brick making. In short he must be a broad-minded, liberally-trained ceramist in all matters covered by that word.

Such a combination of subjects as is indicated above has been arranged in the following courses:

The *Course in Ceramics* is arranged to meet the needs of the manufacturer, affording that scientific training which has a direct bearing upon his business and giving such a knowledge of machinery as will enable him to operate his plant successfully.

The *Course in Ceramic Engineering* is intended to meet the wants of the construction engineer who is interested primarily in the designing and the installation of ceramic plants.

REQUIREMENTS FOR ADMISSION.

42 credits* are required for admission. Of these 5 must be in Algebra, 3 in English Composition, 6 in English Literature, 4 in Geometry—including plane, solid, and spherical—and 6 in German. The remaining 18 may be made up by offerings from the following list, but 6 of them must be in Science.

Electives: Astronomy, 1 to 1½ credits; Botany, 1½ to 3; Chemistry, 1½ to 3; Civics, 1 to 3; Drawing, 1 to 3; French, 3 to 9; Geology, 1½ to 3; German, 3 to 12; History, 3 to 9; Physics, 3; Physical Geography, 1½ to 3; Physiology, 1½ to 3; Zoology, 1½ to 3.

These credits may be acquired either upon examination at the University or upon presentation of diploma and certificate of standing from a school in which these subjects are accredited by the University.

SCHOLARSHIPS.

The University offers every year to each county in the State one scholarship which will be awarded by the Trustees of the University, upon the nomination of the Clay Workers' Association, to applicants who intend to pursue either of the regular courses offered in this circular. These scholarships are good for four years and relieve the student from payment of the matriculation and incidental fees. Their total value is $106 each.

In case it is found at the opening of a year that no applicant has been nominated from any particular

*The term "credit" as used means the amount of work represented by the continuous pursuit of one subject, with daily recitations, thru one of the three terms of the high school year; or, in other words, the work of sixty recitation periods of forty minutes each, or the equivalent in laboratory or other practice.

county, the vacancy may be filled by assignment from such counties as have more than one applicant.

The scholarships will not be granted to persons who have been students in the University, nor to persons under sixteen years of age.

The candidate for a scholarship must, on or before the time of entering the University, satisfy IN FULL the requirements for admission to the freshman class in the College of Science.

ADMISSION AS SPECIAL STUDENTS.

Persons over twenty-one years of age, not candidates for a degree, may be admitted to classes, after satisfying the Dean of the College concerned and the Professor in charge of the Department in which such classes are taught that they possess the requisite information and ability to pursue profitably, as special students, the chosen subjects. Such students are not matriculated; they pay a tuition fee of seven dollars and a half a semester, in addition to the regular incidental fee of twelve dollars.

After successfully completing thirty semester hours of university work, a special student may receive such credits toward matriculation on account of practical experience in the line of his course as the head of the department may recommend and the Dean of the College may approve.

This plan affords the student with a limited amount of time all the advantages of a short course and at the same time secures a good grade of work in the subjects studied.

DEGREES.

The Degree of Bachelor of Science in Ceramics will be conferred on those who complete either of the courses here described.

RESEARCH.

The objects of the courses of instruction in ceramics cannot be properly met unless instruction and research go hand in hand. The student who sees that serious problems of his profession are actually being solved and difficulties cleared away, feels that he is in contact with the practical affairs for which he is making preparation and is led to take a nearby interest in the things with which he has to do. It is expected that all those connected with the work in ceramics will continually be engaged upon problems whose solution will be found helpful to all who are interested in ceramic industries.

EQUIPMENT.

The laboratories connected with the departments of chemistry, physics, geology and engineering, are large, well-lighted, and thoroly equipped for practical work. Students in ceramics make use of this equipment when taking regular courses offered by those departments.

Much of the equipment of the laboratory of economic geology will be especially useful in ceramic work and will be regularly used by students in these courses. It consists of testing scale, jaw crusher, pulverizer, centrifuge, gang-saw for preparing rock specimens for testing, gas-blast and electric furnaces and drying ovens, optical and electric pyrometers, microscopes,

goniometers, balances, picnometers, volumeters, rock sectioning machine, freezing apparatus, air pumps, etc.

The special equipment in ceramics includes:

(1) Chemical apparatus, consisting of complete outfits for the use of instructors and students in the special chemistry of ceramics.

(2) Apparatus for preparing material and manufacturing wares, as follows: Ball mills, jiggers, filter press, small auger brick machine, tile press, jollies, turning wheels, whirlers, pails, pans, sieves, and such small apparatus as is necessary to supply the needs of each student.

(3) Apparatus for burning, consisting of two large kilns, one a muffle up-draft and the other a larger down-draft, both fired with coal; fritt furnaces; gas-blast fuanaces and the pyrometers spoken of above; a supply of seger cones, and a draft gauge.

COURSE IN CERAMICS.

First Year

FIRST SEMESTER

Subject—	S. H.*
General Chemistry Lec Tu Th 4 Sec C Quiz Tu Th 7 Lab M W F 6 7	5
Adv Algebra and Trigonomtry (Math 2 & 4) 2	5
Rhetoric 1	3
Classification and Physical Testing of Clays (Cer 1) M W F 3 4	3
Military	1
Physical Training	1
Total	18

SECOND SEMESTER

Subject—	S. H.*
Qualitative Analysis (Chem 3a) Lec Tu Th 2 Lab 6 7	5
Analytical Geometry (Math 6) 4	5
Rhetoric 1	3
Winning and Preparation of Clays (Cer 2) M W F 3	3
Physical Training	1
Military	2
Total	19

Second Year

FIRST SEMESTER

Subject—	S. H.*
Quantitative Analysis (Chem 5a) Lec Tu Th 3 Lab Tu Th 6 7 8 S 1 2 3 4	5
Physics 1 3 Lec M W 4 Quiz F 4 Lab M 7 8 9	5
Mineralogy (Geol 5) 1 2	5
Military	1
Total	16

SECOND SEMESTER

Subject—	S. H.*
Silicate Analysis (Chem 5a) Lec Tu Th 3 Lab Tu Th 6 7 8 S 1 2 3 4	5
Physics 1 3 Lec M W 4 Quiz F 4 Lab M 7 8 9	4
Geology 1 1 2	5
Physical Calculation (Cer 3) Tu Th 4	2
Military	1
Total	17

* S. H. stands for Semester Hours. A semester hour means an amount of work which will fully occupy three hours of the student's time each week for one semester.

Third Year

FIRST SEMESTER

Subject—	S. H.*
German 4..... 2.....	4
Physics of Heat 16a & 16b Tu F 1 6 7 8.....	4
General Engineering Drawing M W Th 6 7 8.....	3
Free Hand Drawing (A & D1) M W F 3 4.....	2
Drying & Burning (Cer 4) M W Th S 1	4
Total	17

SECOND SEMESTER

Subject—	S. H.*
German 6.....2.....	4
Clay modeling (A & DS) Tu Th 6 7 8	2
Working Drawings (Arch 10) M 6 7 8	1
Body Making (Cer 5) Lec Tu W Th F 1 Lab W F 6 7 S 1 2.....	6
Economic Geology of Ceramic Materials (Geol 2) Tu Th 3	2
Total	15

Fourth Year

FIRST SEMESTER

Subject—	S. H.*
Calculus (Math 8a) 1.....	5
Glazes (Cer 6) Lec M Tu W Th 6 Lab M W 7 8 9	6
Ceramic Stoichiometry (Cer 7) M W 2	2
Analysis of Glasses & Glazes (Cer 8) Tu Th S 2 3 4.....	3
Total	16

SECOND SEMESTER

Subject—	S. H.*
Physical Chemistry (Chem 31) Lec M W F 4 Lab W F 6 7 8	5
Colors of Bodies & Glazes (Cer 9) M Tu Th 6.....	3
Thesis	8
Total	16

COURSE IN CERAMIC ENGINEERING.

First Year

FIRST SEMESTER

Subject—	S. H.*
General Chemistry Lec. Tu. Th. 4 Quiz Tu. Th. 7. Lab. M. W. F. 6. 7	5
Adv. Algebra and Trigonometry (Math. 2 & 4).....	5
German 4 8.....	4
General Engineering Drawing M. W. F. 1 2 3	3
Military	1
Physical Training	1
Total	19

SECOND SEMESTER

Subject—	S. H.*
Qualitative Analysis (Chem. 3a) Lec. Tu. Th. 2 Lab. 6 7	5
German 6 4.....	4
Analytical Geometry (Math. 6) 8..	5
Military	2
Physical Training.....	1
Total	17

Second Year

FIRST SEMESTER

Subject—	S. H.*
Quantative Analysis (Chem. 5a) Lec. Tu. Th. 3 Lab. Tu. Th. 6 7 S. 1 2 3 4	4
Physics 1 3 Lec. M. W. 4 Quiz F. 4 Lab. M. 7 8 9.....	5
Geology 5 Daily 2 M. W. F. 3.....	4
Mathematics 8 1.....	5
Military	1
Total	19

SECOND SEMESTER

Subject—	S. H.*
Silicate Analysis (Chem. 5b) Lec. Tu. Th. 3 Lab. Tu. Th. 7 8 9 S. 1 2 3 4.....	6
Physics 1 3 Lec. M. W. 4 Quiz F. 4 Lab. M. 7 8 9	4
Geology 1 1 2.....	5
Winning and Preparation of Clays (Cer. 2) M. W. F. 3.....	3
Military	1
Total	19

Third Year

FIRST SEMESTER

Subject –	S. H.*
Physics 16a b Lec. Tu. F. 1 Lab. Tu. F. 6 7 8	4
Drying and Burning (Cer. 4) M. W. Th. S. 1	4
Electrical Engineering (E. E. 2) Tu. Th. 4	2
Electrical Engineering Lab. (E. E. 26) S. 1 2 3	2
Rhetoric M. W. F. 6	3
Total	15

SECOND SEMESTER

Subject—	S. H.*
Analytical Mechanics (T. & A. M. 7) Tu. W. F. 3	3
Body Making (Cer. 5) Lec. Tu. W. Th. F. 1 Lab. W. F. 6 7 S. 1 2	6
Working Drawings (Arch. 10) M. 6 7 8	1
Steam Engines and Boilers (M. E. 11) M. W. F. 2	3
Rhetoric M. W. F. 4	3
Total	16

Fourth Year

FIRST SEMESTER

Subject—	S. H.*
Analytical Mechanics (T. & A. M. 8) 3	2½
Resistance of Materials (T. & A. M. 9) Lec. 3 Lab. W. 3 4	3½
Ceramic Stoichiometry (Cer. 7) M. W. 2	2
Glazes (Cer. 6) Lec. M. Tu. W. Th. 6 Lab. M. W. 7 8 9	6
Thesis	1
Total	15

SECOND SEMESTER

Subject—	S. H.*
Surveying (C. E. 10) M. Th. 3 4	2
Geology 2	2
Ceramic Construction	3
Thesis	8
Total	15

COURSE IN LIMES AND CEMENTS.

By making the substitutions indicated below in the course in ceramics, that course will be found to meet the needs of the student wishing to prepare for the manufacture of limes or cements. These substitutions should be made only upon the recommendation of the Director of the courses in ceramics.

Third Year

FIRST SEMESTER.	SECOND SEMESTER.
Omit Art & Design 1 and Ceramics 4. Take Chemistry 65 and Ceramics 11.	Omit Art & Design 8 Take Physics 17.

Fourth Year

FIRST SEMESTER.	SECOND SEMESTER.
Omit Ceramics 6 and 8. Take Chemistry 18 and Civil Engineering 5.	Omit Ceramics 9. Take Ceramic Construction.

DESCRIPTION OF COURSES.

ARCHITECTURE.

10. WORKING DRAWINGS. Conventional methods for representing the different parts of buildings in general and in detail, conventional colors and sectioning; systems of lettering and figuring drawings; working drawings; tracing; drawing for reproduction. (1 hour.)*

ART AND DESIGN.

1. FREE-HAND DRAWING. An elementary course offering lectures on the principles of perspective, followed by drawing practice, and work arranged to be of direct assistance to the students in their several courses in the University. (2 hours.)

8. MODELING. A course in clay modeling comprising work from the antique and from life in relief and the round. Instruction is given in casting. (Frederick's Plaster Casts and How They Are Made.) (2 hours.)

CERAMICS.

1. CLASSIFICATION AND PHYSICAL TESTING OF CLAYS. An elementary course designed to acquaint the student early with the varieties of clays and the properties which adapt each to its special use in ceramic industry. (3 hours.)

2. WINNING AND PREPARATION OF CLAYS. A study of the commercial methods of winning and preparing ceramic materials for the market and factory. (3 hours.)

3. PHYSICAL CALCULATIONS. Problems, and calculations relating to problems in hygrometry and heat, incident to the processes of drying and burning. (2 hours.)

4. DRYING AND BURNING. A detailed consideration of the methods of drying and burning clay wares, and the physical laws underlying these operations. (4 hours.)

5. BODY MAKING. Lectures on the manufacture and body composition of various ceramic wares. Laboratory exercises are given to demonstrate the physical and pyro-chemical effect of variations in processes of manufacture and in composition; also to illustrate the peculiar properties and composition of the various types of bodies. (6 hours.)

6. GLAZES. Lectures on the production of glazes and enamels, their classification and the properties and defects common to each class, with laboratory exercises to demonstrate the fundamental characteristics of each class of glaze; the effect of varia-

*An "hour" means an exercise which requires three hours of the students's time each week.

tion in composition on its physical properties; and the mode of application. (6 hours.)

7. CERAMIC STOICHIOMETRY. Calculations involved in the manufacture of bodies and glazes, using Jackson's "Ceramic Calculations" and the "American Ceramic Society Manual" as a basis. (2 hours.)

8. ANALYSIS OF GLASSES, GLAZES, AND CLAYS. (3 hours.)

9. COLORS OF BODIES AND GLAZES. Methods of opacifying and coloring bodies and glazes, with detailed consideration of the methods of decorating clay wares. (3 hours.)

10. CERAMIC CONSTRUCTION. Original plans, specifications, and estimates of some ceramic construction will be required. (3 hours.)

11. CEMENT. A course of lectures on limes, cements and mortars of all descriptions, giving special consideration to composition, reactions, and methods of manufacture, mining of the raw material, and testing of the finished product. (4 hours.)

12. THESIS. (8 or 9 hours.)

CHEMISTRY.

1. ELEMENTARY INORGANIC CHEMISTRY. This course deals with the general principles of the science. (5 hours.)

3a. QUALITATIVE ANALYSIS. This course consists of lectures, recitations, and laboratory practice in the ordinary processes of qualitative analysis. (5 hours.)

5a. ELEMENTARY QUANTITATIVE ANALYSIS. The laboratory work comprises a series of experiments which illustrate the fundamental principles of gravimetric and volumetric methods. The lectures and recitations consist of a consideration of stoichiometrical relations, the fundamental laws of chemistry and their application to the study of solutions. (5 hours.)

5b. SILICATE ANALYSIS. A comparative study of methods with practice in the analysis of silicates. (5 hours.)

18. CEMENT ANALYSIS. A special course in the analysis of limes, cements and cement-making materials. (3 hours.)

65. GAS ANALYSIS. Examination of gases, gas mixtures, flue gases, and fuels. Determination of calorific values, and calorimetric efficiencies. (2 hours.)

31. ELEMENTARY PHYSICAL CHEMISTRY. This course, extending through one semester, is designed to give an elementary knowledge of the paramount facts of physical chemistry and their relations to common and practical chemical problems. The instruction is by lectures and recitations, supplemented by work in the laboratory. (Walker's Introduction to Physical Chemistry.) (5 hours.)

ENGINEERING.

C. E. 10. SURVEYING. For students in the course of architecture, architectural engineering, electrical engineering, mechanical engineering, and ceramics. (2 hours.)

M. E. 11. STEAM ENGINES AND BOILERS. For students in other departments of the College of Engineering, and Ceramics. The course includes the construction, operation, and care of boilers and engines; elementary thermodynamics; the indicator and indicator diagrams; compounding, jacketing, and superheating; condensers; steam engine performance. (3 hours.)

E. E. 2. ELECTRICAL ENGINEERING. Lectures and recitations accompanying Electrical Engineering 26, laboratory practice; for students in civil engineering and ceramics. (2 hours.)

E. E. 26. ELECTRICAL ENGINEERING LABORATORY. For students in civil engineering and ceramics. (2 hours.)

Required: Registration in E. E. 2.

GENERAL ENGINEERING DRAWING.

1. GENERAL ENGINEERING DRAWING. Consists of: (*a*) Lettering—Plain free hand lettering alphabets, off-hand lettering, and titles. (Wilson's Free-hand Lettering.) (*b*) Elements of Drafting—Use of instruments, simple line exercises, geometrical construction, tracing and working drawings. (*c*) Sketching—Free-hand dimensioned sketches of engineering details, time sketches and shop exercises. The three are accompanied by lecture courses upon the respective subjects. (3 hours.)

GEOLOGY.

1. DYNAMIC AND HISTORIC GEOLOGY. Dynamic and historic geology. Laboratory exercises in petography and paleontology.

a. Dynamic Geology. The forces now at work upon and within the earth's crust, modeling its reliefs, producing changes in the structure and composition of its rock masses and making deposits of minerals and ores. A series of localities is studied in which great surface changes have recently taken place, with a view to ascertaining the character of the forces producing such changes, and the physical evidence of the action of like forces in the past.

b. Petrography of Fragmental Rocks. A laboratory study of fragmental rocks, following the same lines as indicated under 5b.

c. Historical Geology. Substantially an introduction to the history of geology. Especial stress is laid on the development of the North American continent.

d. PALEONTOLOGY. The scheme of instruction in this subject places before the student the classification adopted for those

organic forms occurring as fossils, together with the succession of the various groups in the strata, with the cause, as far as known, for their appearance and disappearance. The student is required to familiarize himself with selected groups of paleozoic fossils, abundant illustrations of which are placed in his hands. (5 hours.)

2. ECONOMIC GEOLOGY. A study of the use which may be made of geologic materials; of the conditions under which they occur; and of the qualities which make them valuable. Readings, conferences and laboratory work. Each student may, with the approval of the head of the department, select one or more of the subjects indicated below and devote to it as much time as may seem desirable and profitable. The proportion of time devoted to reading, conference and laboratory will of course vary with the nature of the subject chosen. The new laboratory affords facilities for making the work thoroly practical.

The subjects from among which students may elect for the purpose of special investigation are as follows:

Ores and ore deposits; useful minerals other than ores; mineral synthesis. Petrographic studies, properties of clays, which fit them for various uses. Properties of lime and cement-making materials. Properties of building stones. Rock-flours and their uses. Origin and uses of road metals. Studies of ornamental stones. Coal and coal basins. Hydrographic studies. (2 hours.)

5. ELEMENTS OF MINERALOGY, CRYSTALLOGRAPHY AND PETROGRAPHY OF CRYSTALLINE ROCKS. (*a*) Mineralogy and Crystallography. In the lectures such subjects as follows are discussed. Genesis of minerals; conditions favoring their deposition; origin of the massive and crystalline forms; relationships of minerals and their classification; the physical properties of minerals, with the conditions which may cause them to vary; the elements of crystallography, including a study of the typical whole, half, and quarter forms of each system, and their identification when in combination. In the laboratory the student is made acquainted with the simplest trustworthy methods for proving the presence or absence of the acids and bases. He is then required to determine a large number of species by their physical and chemical properties only; to trace the origin, transformation, and relationship of each, and explain any variations from the typical form, composition, or physical characters which may occur.

b. PETROGRAPHY. The classification of rocks, the methods used in their determination, the conditions governing the formation of each species, the decompsitions to which they are liable and products of these decompositions. (5 hours.)

ENGLISH.

1. RHETORIC AND THEMES. (6 hours.)

GERMAN.

4. Descriptive and historical prose selections from standard prose writers, sight reading. (4 hours.)

6. SCIENTIFIC PROSE. Practice in the rapid reading of works of a general scientific character. (4 hours.)

MATHEMATICS.

2. ADVANCED ALGEBRA. This course is for those students who wish to cover in five hours of mathematical work the subject of college algebra and that of plane trigonometry (Math. 4.). (3 hours.)

The following topics are considered: Progressions, undetermined coefficients, binomial theorem, logarithms, permutations and combinations, probability, convergence of series (or determinants), and the theory of equations, with special reference to the solution of numerical equations of the third and fourth degree.

4. PLANE TRIGONOMETRY. (2 hours.)

6. ANALYTICAL GEOMETRY. The aim is to acquaint the student with analytical methods of investigation and to familiarize him with the general properties of conics, including a discussion of the general equation of the second degree and its geometrical interpretation. Special emphasis is placed upon the use of algebraic processes as a means of demonstrating geometrical properties of loci. To this is added a brief course on the analytical geometry of three dimentions, including co-ordinate systems in space, the relation of points, straight lines, and planes in space, as also the general properties of surfaces of second order. (5 hours.)

8 a. DIFFERENTIAL AND INTEGRAL CALCULUS. A general introduction to the principles of differential and integral calulus. (5 hours.)

7, 8. ANALYTICAL MECHANICS. The mechanics of engineering, rather than that of astronomy and physics, is here considered. Attention is given to fixing the fundamental concepts and demonstrating the general principles and methods of equilibrium and motion and also to the application of principles and methods to numerous and varied engineering problems. Training in the statement of conditions and in the use of data is given. This subject requires a thoro working knowledge of the mathematics preceding it in the course. The work begins in the second semester, and in the following semester it is given in connection with Theoretical and Applied Mechanics 9. (Maurer's Technical Mechanics.) (5½ hours.)

9. RESISTANCE OF MATERIALS. In the treatment of this subject it is the aim to give the student a thoro training in the elementary principles of the mechanics of materials, to follow with such experiments and investigations in the materials labora-

tory as tend to verify the experimental laws, and to add such problems in ordinary engineering practice as will train the student in the use of his knowledge. Attention is also given to the quality and requirements for structural materials. (Merrimans's Mechanics of Materials.) (3½ hours.)

MILITARY SCIENCE.

1. THEORETICAL INSTRUCTION. Infantry drill regulations. For all male students. (1 hour.)

2. PRACTICAL INSTRUCTION. Infantry. School of the soldier; company and battalion; evolution of the regiment. Artillery.—School of the cannoneer and battery dismounted. Freshman and sophomore years. (4 hours.)

PHYSICAL TRAINING.

1. GYMNASIUM PRACTICE. Two hours' class work, calisthenic drills and heavy apparatus work, each week. Required of freshman. (½ hour.)

2. GYMNASIUM PRACTICE. Three hours each week in advanced heavy apparatus work. (2 hours.)

PHYSICS.

1. GENERAL PHYSICS. Lectures with class-room demonstration, recitations and written exercises. This course is required of students in engineeing and is recommend to students with major work in physics and mathematics. The laboratory course, Physics 3, is to be taken at the same time. (3 hours.)

3. INTRODUCTION TO PHYSICAL MEASUREMENTS. Laboratory experiments running parallel with the lecture course. (4 hours.)

16a. HEAT. Lectures and recitations with occasional class-room demonstrations. Dicussions and demonstrations of fundamental heat phenomena are given, together with the elements of the mechanical theory of heat. The course on heat Measurements, 16b, is to be taken with this course. (2 hours.)

16b. HEAT MEASUREMENTS. Laboratory exercises including thermometry, calorimetry, determination of vapor pressure and density, melting and boiling points of substances, linear and cubical coefficients of expansion. This course is to be taken in connection with Physics 16a. (2 hours.)

17. THERMOMETRY OF HIGH AND LOW TEMPERATURES. Primarily a laboratory course, but with frequent recitations on the theory of the measurement of extreme temperatures. (LeChatelier's High Temperature Measurements.) (2 hours.)

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